

April 2, 1929.

F. A. HEATH

1,707,474

OIL BURNER

Filed Aug. 3, 1925

4 Sheets-Sheet 1

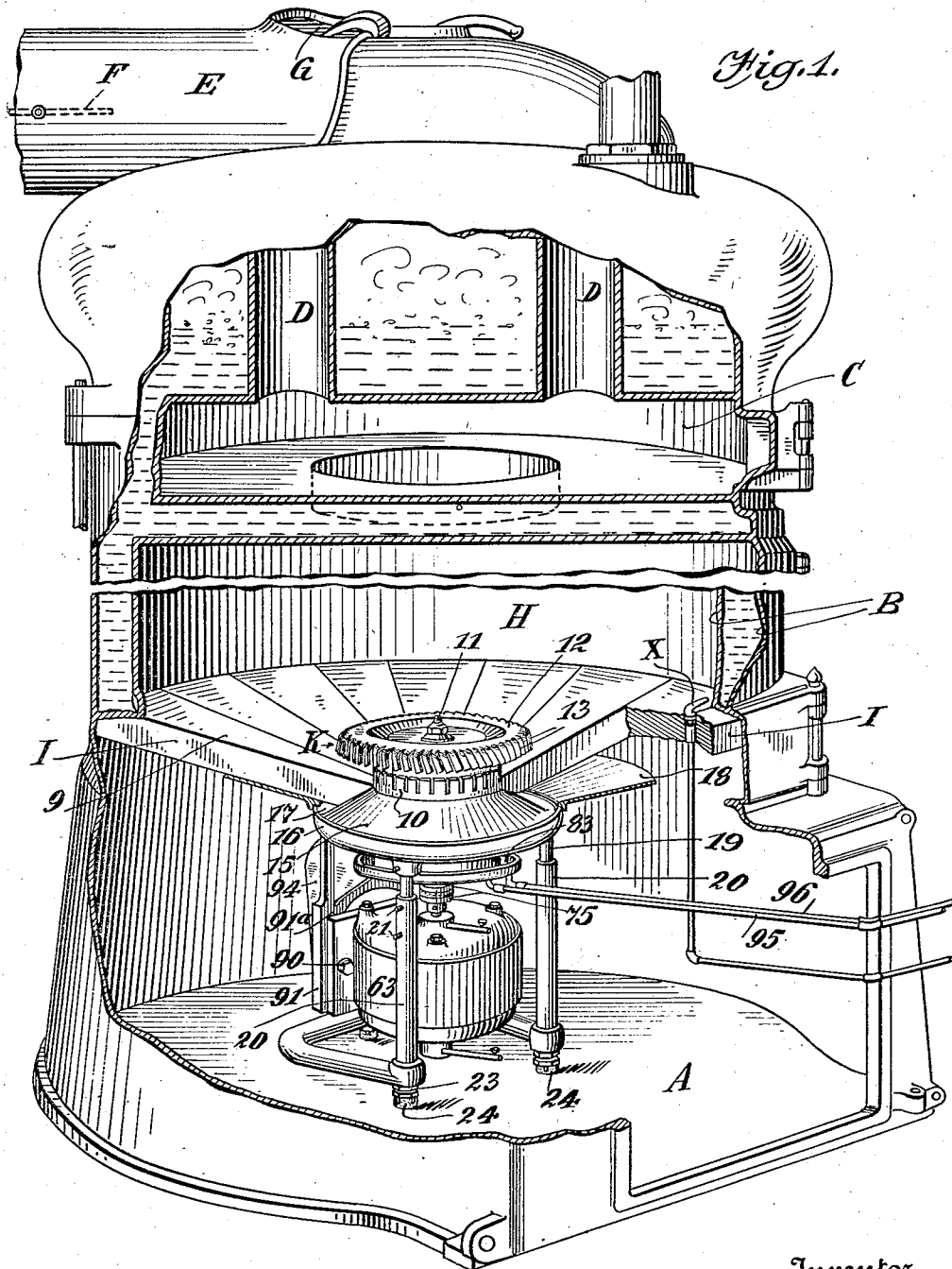


Fig. 1.

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April 2, 1929.

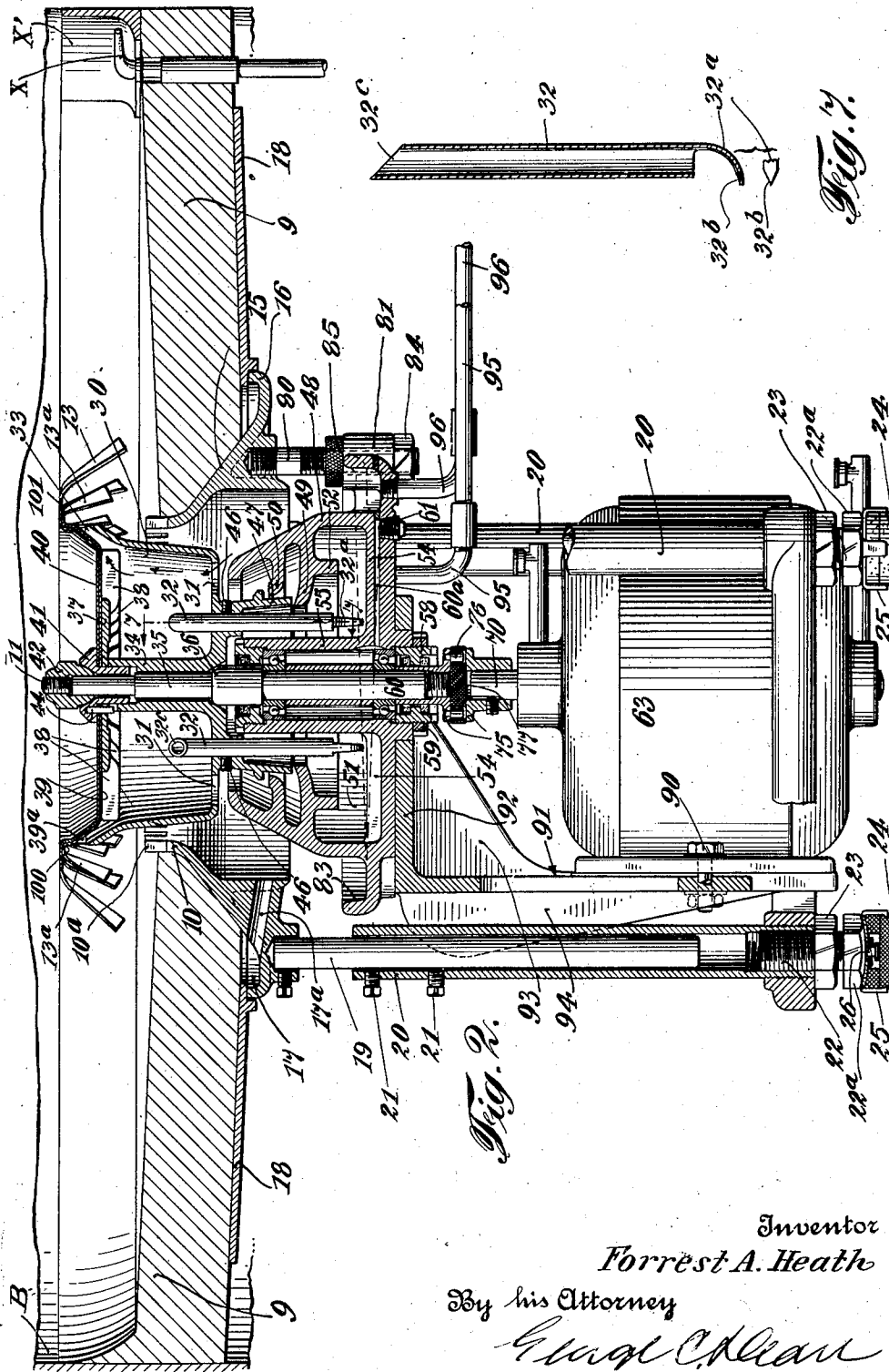
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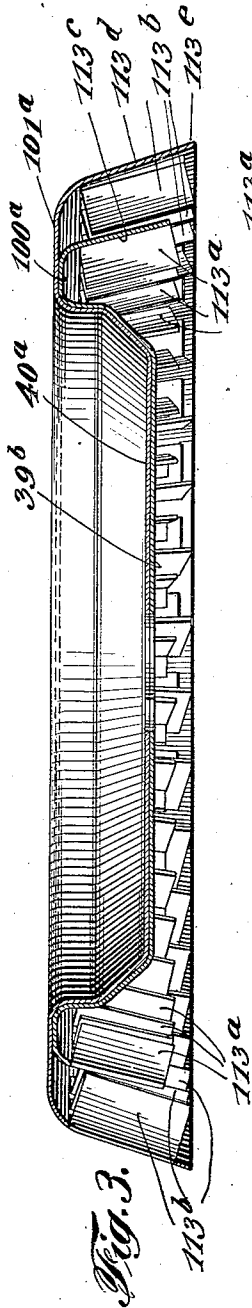


Fig. 3.

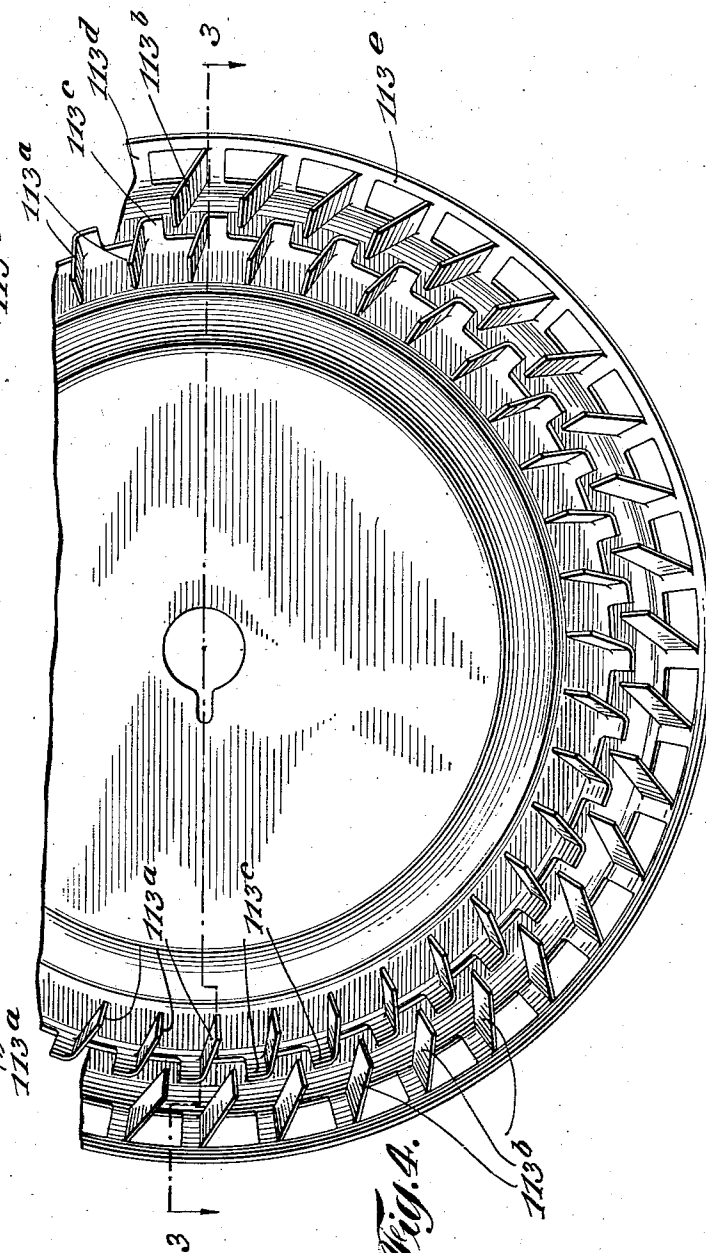


Fig. 4.

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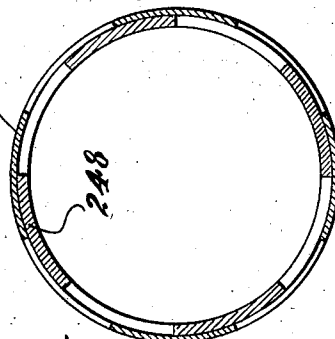
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OIL BURNER

Filed Aug. 3, 1925

4 Sheets-Sheet 4



UNITED STATES PATENT OFFICE.

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OIL BURNER.

Application filed August 3, 1925. Serial No. 47,708.

My present invention is shown in connection with an oil burner of the so-called automatic type adapted to burn liquid fuel, particularly the heavier or so-called fuel oils, and the construction of the burner unit peculiarly adapts it for converting ordinary coal burning furnaces into oil burners; but it will be evident that various features of the invention may be applied to other burners adapted for other uses.

The apparatus includes means for initially forming a crude, over rich carbureted mixture of oil spray suspended in and projected with a relatively small percentage of primary air, in combination with special homogenizing and propelling means whereby the spray in this initial draft is atomized and intimately mixed with said initial air and also with some additional primary air and the whole projected as a homogeneous fuel draft in close relation to the main draft of air necessary for complete combustion. This fuel draft may be caused to burn according to my newly discovered method described below; but various features of the homogenizing and propelling means may be used in connection with fuel mixtures of primary air with vapors or even gases derived from other sources or where the combustion is not caused to develop according to the preferred form of carrying out the invention.

The means for forming the initial spray and air draft is shown as being of the centrifugal spray cup type. A small electric motor is employed to rotate the cup at the speeds required for centrifugal operation and preferably this same motor is utilized for driving my homogenizing and propelling means.

In the preferred embodiment, the draft mixture is propelled outward, in a circular sheet, above a hearth that closes the greater part of the bottom of a furnace so that chimney "suction" or equivalent draft-inducing difference of pressure is caused to take effect through the air inlets controlling the main supply of air for supporting complete combustion, preferably this main air draft is through an annular inlet closely surrounding the atomizer outlet and preferably the main air draft is directed upward to intersect the path of the initial air and spray mixture.

An important feature of the invention is

the attainment of practically perfect combustion without the use of excess air, yet with practically noiseless operation and freedom from roaring which has heretofore been an unavoidable accompaniment of efficient combustion of sprayed or atomized fuel oil.

According to the preferred method, the combustible mixture is projected outward from a central rotor with such force and under such conditions that the mixture will be ignited and the flame will begin around a circumference as remote as may be desired from the rotor, with the result that the flame line may be localized adjacent the edge of the hearth where it joins the wall of the furnace or boiler, so that the flame line will be the lower edge of a continuous wall or cylinder of flame conforming to and, as it were, clinging to the inner surfaces of the walls to be heated.

This cylinder of flame is closed at the bottom and its inner surface cut off from the main air supply by the high velocity, outwardly flowing layer of fuel mixture. The upper face of this layer does not ignite because its air content is too small and too uniformly distributed. Hence instead of burning it becomes preheated ready for the energetic combustion that follows impingement on the surrounding walls. Furthermore, the upper surface of this sheet entrains from above some of the burned out air which is deficient in free oxygen and rich in carbon dioxide while the lower surface entrains fresh air. When this composite sheet impinges on the encircling walls, the impact and commingling of constituents results in a flame which is slow-burning and of non-explosive quality particularly on the inner or exposed surface, whereas the surface contacting with the boiler or furnace wall is much better supplied with oxygen. Consequently, the exposed surface has no roaring tendency while the maximum heat development is close to the wall to be heated.

The circular wall of flame which I produce in this way, though remarkably uniform, is likely under varying conditions of operation to become somewhat more dense and hotter around some parts of the circumference than others, and a very remarkable feature of my invention is that I am able to cause the entire wall of flame to slowly rotate around the axis of the burner along the

walls that are being heated, so that non-uniformities or eccentricities of the heat development are not localized in any one spot but tend to travel slowly around the walls of the furnace. This effect is a resultant of several factors, particularly the use of a fan rotor that discharges a relatively powerful blast along lines more or less tangential to a circle which is of substantial diameter as compared with the diameter of the furnace or boiler. The non-radial impingement of such a draft on the outer walls results in the above described slow rotary movement of the flame.

The most important factor in obtaining the above effects is the combination with the primary air and spray projecting means, of a secondary or homogenizing propeller or fan located in the path of the rich mixture from said primary means. This propeller is preferably designed and operated so as to deflect, baffle and homogenize the primary air and oil mixture together with a substantial admixture of additional primary air, while ensuring the desired high radial velocity of the draft as a whole. By using fan blades having a forwardly wedging component, as in propellers, the blades may be arranged so that they intercept and break up all outwardly projected spray drops in the primary mixture, while at the same time greatly accelerating the draft as a whole. The thorough homogenizing thus accomplished makes it possible to mix in additional primary air to a percentage much nearer that necessary for perfect combustion than has been heretofore practically attainable. That is to say, in prior motor driven oil sprayers where the propulsion is mainly by centrifugal force, the primary carbureted mixture may be as a whole very deficient in air yet certain regions or spots contain mixtures where the air and oil are in approximately explosive condition so that ignition occurs at such points and the combustion line creeps in quite close to the burner, while relatively large drops of oil are thrown against the walls of the furnace or drop on the hearth under conditions entirely unsuitable for perfect, efficient combustion.

The interference and homogenizing function of my supplemental fan is clearly distinguishable from its high velocity propelling function although these two functions are best served each in combination with the other.

The homogenizer preferably includes two separate sets of blades operating in succession on the spray. Preferably they are concentric, the inner set encircling the spray projector and, in turn encircled by the outer set. They thus present successively higher peripheral speeds to the outwardly traveling sprayed mixture. These blades are carried by an annular rim that projects horizontally

into the path of upward draft from the annular air inlet, deflecting and baffling said draft where it intersects the path of the spray, thoroughly mixing part of it with the spray and, under most conditions, deflecting part of it outwardly so that the lower face of the outwardly traveling draft adjacent the hearth may be practically pure air.

As concerns projecting the mixture outward, the two sets of blades cooperate sufficiently to give the required outward velocity, but a coordinate function of even more importance is breaking up and atomizing the oil particles and homogenizing their mixture with the air. Hence they are designed for substantial interference and baffling of the spray and draft.

While the blades will be of substantial advantage if set radially, as in paddle wheels, I prefer to have them inclined to the direction of peripheral movement and also inclined to the plane of rotation, so that they have an inclined plane or wedge propelling effect as in a screw propeller as well as the centrifugal blower or paddle wheel effect. Preferably, the wedge propelling effect is upward and as the inner set of blades is closed at the top by the above described rim or wall at right angles to the axis, the draft movement in this direction is baffled producing compression, deflection and eddy effects that contribute to the atomizing and homogenizing of the mixture. The outlet side of the outer set of blades is not closed above and this set of blades freely propels the homogenized part of the draft outward in a circular sheet having its lower surface overlying and merging into the purer air which has been deflected along the upper surface of the hearth.

I am able to secure the above homogenizing and propelling effects with a rotor say seven or eight inches in diameter driven at relatively low speed, say 1700 or 1800 revolutions per minute. These speeds are economical and are not destructive on the motor. Others have employed motor speeds twice as great without attaining or even discovering the possibility of the above described features of oil burning according to my invention.

Furthermore, when the device is installed and operating as above described, whereby the non-burning sheet extends entirely to the walls of the furnace or boiler so that the upper face of the non-burning sheet and the inner face of the flame cylinder are entirely cut off from free air, the diluent action of the products of combustion which fill the interior of the furnace is so great that temperatures on the top of the burner within the furnace are in many cases 400° and 500° less than in the case of any prior burners of this type. Furthermore, the temperatures below the hearth in the ash pit where the

motor is are very much lower so that the insulation as well as the lubrication of the motor is easily accomplished without the necessity for expensive construction or skilled attendants.

The above described control of hot water and boiler heating results in the production of a bright, slow, relatively low temperature flame, due to the diluent action of the carbon dioxide and other products of combustion that fill the space enclosed by the flame; and is of particular advantage for such purposes because there is no intense heat evolution at any one point and the slow, clinging flame sheet extends upward to the crown sheet and into the flues where the final phases of complete combustion are evidenced by the blue flame characteristic of hydrogen and carbon-monoxide combination.

It is to be understood, however, that the blast of draft mixture which I am able to produce by means of my homogenizer includes vapor in suspension and is more like a gas than a mixture, and it may be controlled to burn in various ways. For instance, by cutting down the stack draft and thereby reducing the air supply, the highly colored flame may be made to entirely disappear, in which case the whole body of the furnace will appear to be filled with a slightly bluish or almost invisible flame, indicating that my homogenized mixture has some of the qualities and may be used to produce effects similar to those attainable by manipulating the air supply of ordinary illuminating gas, and I attain these results with ordinary fuel oil.

The above and other features and novel details of my invention will be more fully understood from the following description in connection with the accompanying drawings, in which

Fig. 1 is a view of one form of my burner and one form of installation and use thereof, the burner and parts of the furnace in which it is installed being shown in perspective and parts of the furnace being broken away;

Fig. 2 is a vertical axial section through the burner and a portion of the hearth;

Fig. 3 is a vertical section on the line 3—3, Fig. 4, showing a form of homogenizing mixer and propeller which is preferred for use in place of those shown in Figs. 1 and 2;

Fig. 4 is a plan view from below, Fig. 5;

Fig. 5 is a vertical section like that of Fig. 2 but showing modified details of construction;

Fig. 6 is a sectional detail on the line 6—6, Fig. 5; and

Fig. 7 is a sectional detail on the line 7—7, Fig. 2.

In Fig. 1, I have shown a complete installation in accordance with my present invention, because as is evident from the foregoing explanation of the preferred opera-

tion, there is a true combination between the oil atomizer and projector and the furnace in which it is installed, the latter being in effect the burner and the former being not really a burner but rather a carburetor for supplying the periphery of the hearth with a peculiarly uniform, stratified, combustible. As shown, the furnace is of conventional type, comprising an ash pit A, boiler walls B, combustion dome C, flues D, D, communicating with the chimney, not shown, through pipe E, which may be controlled by the butterfly damper F and air inlet G. Such a furnace may be of conventional type, originally designed for coal burning, but for my purposes the grate has been removed and the combustion chamber H closed in at the bottom by hearth I of refractory material at the center of which is the annular air inlet surrounding the rotary spray cup carburetor K.

The air draft is through collar 10, through which projects shaft 11 carrying homogenizing rotor 12 having propeller blades 13 surrounding the outlet from the centrifugal spray cup 30, which is also mounted on said shaft.

As shown more clearly in Figs. 2 and 5, there is an annular passage between the spray cup 30 and collar 10, not only for clearance to permit rotation of the former, but also to provide for the main air draft that is drawn into the furnace by chimney suction.

The collar 10 is supported by a platform member 15 having an upstanding flange 16 defining a drainage groove 17 and affording a support for the circular plate 18 on which rest the inner ends of the hearth blocks. Near the edge of the hearth, and preferably outwardly directed, is a gas pilot light burner α , which is kept continuously burning by gas supplied from any suitable source. The weight of the hearth support 15, 16 is carried by leg sections 19 telescoped in leg sections 20 and adjustably held by screws 21. There are preferably three legs to afford three-point support.

As shown more clearly in Fig. 2, each leg section 20 has screw-threaded into the lower end thereof, an adjustable extension 22 secured by lock nut 23, whereby the legs may be readily adjusted to true vertical even though the floor of the ash pit be very uneven. The lower end of each member 22 is preferably headed as at 22^a, and the head is cushioned by a rubber block 24, held by metal clip 25 secured by central screw 26. Three-point support makes the adjusting operation easy.

Projecting through and concentric with the collar 10 is the centrifugal or carbureting spray cup 30, formed at the bottom with inlets 31 for the primary air and carrying the picker tubes 32 for supplying the oil to

be mixed with the air and projected from the top of the cup at 33. The cup is formed with a central tubular member 34 fitting the vertical shaft at 35 and resting on an enlargement thereof as at 36. On top of this tubular projection is fitted a disc 37 carrying radial fan blades 38. On disc 37 is clamped a cover member 39 which closes the whole top of the cup and which is dish-shaped so that its peripheral wall 39^a is approximately parallel with the lip portion of the cup. Obviously the cover member 39 may be considered as part of the cup 30. In the form shown in Fig. 2 there is a second cover member 40 fitted on top of 39. Preferably these covers 39 and 40 carry the baffle annulus and the propeller blades described below. Disc 37 and cover plates 39 and 40 are clamped down on the top of the tubular cup member 34 by an annular clamping collar 41 secured by a clamping nut 42. All of the parts may be sufficiently held against rotation on the shaft 35 by the clamping action of nut 42, but I prefer to provide a key 44 engaging clamping collar 41 and extending through 40, 39 and 37 into 34, as shown.

The bottom of the cup 30 is thickened downwardly to provide an adequate lateral bearing for the picker tubes that extend downwardly therethrough and are secured therein in any desired position of vertical adjustment by means of screws 46. Also integral with the bottom of the cup and outside of the downwardly extending picker tubes is a circular depending lip 47 adapted to close the opening into a suitable oil well casing 48. This casing is preferably provided with a plurality of horizontal diaphragms, as 49 and 50, which clear the rotary closure 47 and with it form a labyrinth facilitating downward drainage of oil into the oil supply chamber or well 51 and baffling escape of oil from said chamber to the outside. The depending annulus 52 serves similarly to baffle splash and damps wave motion that may be set up by the pickers when rapidly rotated to lift the oil. Rotation of the oil is damped by radial ribs 54 projecting from the bottom of the oil reservoir almost to the level of the normal surface of the oil.

The oil well has a cylindrical barrel 55 and the cup bearing shaft 11, 35 has a downward extension 60 which is journaled on ball bearings in said barrel. For lubricating purposes the top and bottom of the barrel below the lower ball bearing and above the upper ball bearing are closed by packing held in bushing 58 screw-threaded therein, the lower one being secured by lock nut 59. The cavity is initially filled in with bearing grease and additional grease may be forced in at any time through duct 60^a by removing screw plug 61 and applying a grease gun.

Below the shaft and in alignment there-

with is the electric motor 63, which may be of ordinary construction adapted to use alternating or direct current, and designed to rotate the spray cup, pickers and homogenizing propellers carried thereby at the required speed which, as explained above, may be as low as 1700 to 1800 revolutions per minute for a model built on a scale which will make the extreme over-all diameter of the homogenizer eight (8) inches.

The armature shaft 70 of motor 63 is detachably secured to the spray cup shaft by a flexible coupling conventionally indicated as comprising two similar members 75, 75, each having driving lugs 76, engaging a block 77 through which the driving thrust is applied.

The oil well structure and motor are supported in any suitable way. As shown in Fig. 2, the oil well has three-point support from the platform member 15 by means of stud bolts 80 screw-threaded into 15 and passing through vertically apertured ears 81 which are integral with and outside of a drainage gutter 83 which is integral with the oil well. Any desired position of vertical adjustment for the oil well, drive shaft and spray cup carried thereby may be fixed by lock nut 84, vertical displacement being prevented by thumb nut 85. In the form shown, the motor is secured by screws 90 adjustably engaging a depending bracket 91 which is secured to the bottom of the oil well casing by flange 92 fitting against the same and secured thereto by screws not shown. The vertical bracket member 91 is stayed by deep flanges 93, and 94.

Oil is supplied through the bottom of the oil well by pipe 95 and waste oil from collecting gutter 83 is drained off through pipe 96.

The gutter 83 is in position to collect oil from the spray cup and also from the groove 17, which discharges through the duct 17^a, but its main purpose is to collect oil that drains from the inclined hearth when the pilot light fails or for any other reason when oil is being discharged at a rate greatly in excess of the rate at which it is being burned. In such cases the oil drains down the incline of the hearth and through the slots 10^a in collar 10 and drips into the collecting gutter 83, whence it goes through pipe 96 to a suitable control mechanism forming no part of my present invention. It is sufficient to say that this mechanism accurately controls the level of the oil in the oil well and completely shuts off the supply of oil whenever there is excess drainage through pipe 96.

The picker tubes are preferably of the shape shown in Fig. 7, the picker at the lower end consisting of a narrow integral extension 32^a formed by cutting away the tube, bending it horizontally through some-

thing less than a quadrant of a circle and cutting the end to V-shape, as at 32^b so that it acts as a plow to throw aside the oil that is not skimmed off by the upper surface of the picker. The thin film of oil is skimmed off by reason of the fact that the oil is stationary while the picker tip is traveling circularly at high linear speed around a circle which may be, say, six or eight inches in circumference, driven by a motor which is rotating, say, 1750 revolutions per minute. Although the oil is mobile, it is held by inertia against the thrust of the picker and is deflected upward through the tube at high velocity. Air is also carried up in the same way and the upward movement of both of them is facilitated by the fact that the tube is cut off at an angle on the rear side as shown at 32^c. The effect is that since the speed of rotation of the upper end of the tube is greater than that of the air within the spray cup, there is a suction effect applied at the outlet. In this connection, it is to be remembered that an even greater suction effect is applied by reason of the fact that the cup itself is a centrifugal blower and tends to draw in air through tube 32 as well as through the regular air inlet 31. Obviously also the picker is itself an air scoop as well as an oil scoop.

The amount of oil supply can be gauged with greatest accuracy by adjusting the depth of oil in the oil well, and one advantage in having the picker cut away to a mere finger as shown in the drawings, is that the amount of oil lifted will be more nearly proportional to the depth of the oil. The amount of oil could also be varied by vertically adjusting the picker tubes, but this is an undesirable way, since the oil level in the well should be kept as near the top of the ribs 54 as is practicable, thereby making the ribs as effective as possible in preventing the pickers from imparting rotary motion to the oil, it being obviously desirable to minimize all disturbances of the oil and hold it stationary as against the scoop action of the pickers.

The spray thrown from the upper end of the picker tube is subjected to centrifugal force tending to drive it through the air currents within the cup 30 and in practice much of its impinges on the side of the cup adjacent the outlet annulus. Much of it, however, goes into suspension in the primary air, which is discharged through the same outlet by centrifugal force which is assisted by the fan blades 38, although the latter may be omitted if desired. The richly carbureted mixture is discharged upwardly against the horizontal baffle annulus 100 of the cover member 39, and the adjacent bases of the inner propeller blades 13^a. The unsuspended oil creeps up the walls of the cup by centrifugal force and is projected in

minute drops against the intermediate portions of said blades. This is on a level below the primarily carbureted air and in the path of the main air draft coming up through the collar 10 at an angle to the horizontally projected liquid. This tends to drive upward the minute drops that have been shattered by impact with the inner faces of the blades 13^a, toward the baffle plate 100 and those that have been caught by the outer surface of blades 13^a upward toward the horizontal or baffle annulus 101 of the outer propeller. As a result of the baffling, eddying, mixing and shattering thus produced, a desired amount of additional primary air becomes incorporated in homogenized mixture with a finely atomized liquid which is propelled outward. A large part of the upward main draft, however, is deflected part being driven outward by the propeller blades as an air stratum merging into a richly carbureted stratum, another part eddying back and being again projected upward by the injector action of the upward part of the draft stream. As before pointed out, the radially projected stratum has its upward surface exposed to the products of combustion within the chamber and entrains and merges with both the upper and lower sheets as it attenuates by spreading along the divergent lines of the circle.

The effect of the homogenizing propeller is to baffle the main air draft and to give it such high outward velocity that if any particles of oil remain too heavy for suspension in the carbureted mixture they will nevertheless be carried along toward the periphery of the hearth or, if any of them fall on the hearth, as when the furnace is being started up, they will be speedily evaporated and swept to the periphery of the hearth.

The homogenizing propeller may be made in a variety of ways provided the blades be formed with a view to propelling as well as baffling and homogenizing the draft. In Fig. 1, the blades are formed by radially slitting a circular disc to form narrow blades and then bending these blades downward so that they will surround and extend below the lip of the centrifugal carbureter cup and also twisting them so that they will have the outward wedging or propelling effect in addition to the centrifugal effect and the baffling effect. Even as shown in Fig. 1, the blade substantially encompasses the outlet of the cup so that when in rapid rotation, any drops from the lip of the cup are intercepted and shattered. Even so, it may be advisable to use an inner homogenizer of similar construction but of less radius and preferably with blades of greater pitch than the outer blades. As before pointed out, the inner set of blades have greater peripheral speed than the lip of the cup and the outer set of blades has

greater peripheral speed than the inner set.

A rugged construction for the above purpose in which the blades are combined with extensive baffle surfaces at angles between 45° and 90° to the path of outwardly projected drops, is shown in Figs. 3 and 4. Here the cover discs 39^b and 40^a have the horizontal baffling surfaces 100^a and 101^a respectively. They are stamped to the transverse curvature shown in Fig. 3 and then a portion of the outer walls is slitted and bent-in. The blades 113^a of the inner set are more nearly radial than are the blades 113^b of the outer set. The unbent portions, 113^c and 113^d, of the respective flanges are without propelling effect and serve the function of baffles and deflectors with a downward component. The outer set of blades has a marginal rim 113^e, which increases the structural strength of the anchorage for blades 113^b and also serves as a guard to lessen danger from contact with the periphery of the device while it is rotating at high speed.

In Fig. 2 the homogenizing propellers are shown as being scantily supplied with propeller blades. Good results may be obtained by having the spaces between the blades in each set approximately equal to the widths of the adjacent blades, particularly if the registry is such that a blade 13^a coincides with each space between blades 13, but in general it will be found that the close setting shown in Fig. 1 and even the non-propelling baffle surfaces 113^a in Figs. 3 and 4, will produce better results. In all cases, however, much depends upon the proportions, designs and pitch angles of the blades as well as on their distance apart and relations to each other.

A somewhat different arrangement of homogenizing propeller is shown in Fig. 5. Here the outer propeller carried by the motor shaft and rotating at the same speed as the cup may be the same as that shown in any of the figures above described, but in lieu of the inner propeller I may arrange a stationary set of blades 213, mounted on an upwardly extending sleeve 248 spaced apart from the outer wall of the cup 230 a sufficient distance to permit passage of all or a large part of the main air supply. The stationary blades 213 at the upper edge thereof are inclined outwardly and are also twisted about their longitudinal axes so that they furnish inclined surfaces deflecting the spray from the cup outlet annulus upwardly and circumferentially forward in the direction of rotation of the cup. This causes deflection of the draft mixture and also the main air supply toward the rear faces of the rotating blades 13, but the stationary blades may be more nearly radial and may even be inclined in the opposite direction so as to tend to baffle the draft in a direction contrary

to the direction of rotation of the blades 13. In the preferred arrangement, the blades 213 tend strongly to deflect the drops from the draft upward toward the baffle surface 101.

As the stationary blades have no rotary motion tending to throw off the oil by centrifugal force, I may provide the outside of the cup with helical propeller blades 228 designed to powerfully accelerate the main air draft in its upward movement so that it will be effective in its tendency to strip the oil upward off of the upper ends of the blades 213.

The enclosing of the main air draft by the cylindrical wall 248 makes it possible to closely control the amount of air in this draft by means of a rotary damper 250 (see Fig. 6) controlled by an operating handle 350 projecting outward beyond the leg supports of the device.

This figure also differs from the others in that the spray cup 230 is flared outward more nearly in parallelism with the natural trajectory of the spray and air thrown from the outlet ends of the tubes 32, thus allowing more of the oil to be carried through the outlet annulus without impingement on the walls of the cup. Moreover, such drops as do impinge on the walls will be cleared therefrom more rapidly by reason of the more favorable angle of impingement and also because of the much greater effect of centrifugal force due to the wide angle of the mouth of the cup. In this Fig. 5 the motor and other rotating parts are carried by adjustable stud bolts 80, very much as in Fig. 2, but the drip trough 285 is on a lower level and more accessible. It is in position not only to receive drip from the hearth, but also from an opening at 290 in the side of the oil well. This opening is well above any level the pickers are intended to work at and will only come into operation in case the oil well is flooded.

A further feature is having the baffles for preventing rotation of the oil not only along the bottom of the oil well as at 254, but also around the sides of the well as at 354.

As explained above, my invention is not limited to the details of construction above described, nor is it limited to the preferred method of use. Any of the homogenizer constructions shown in the other figures may be used in combination with the carbureting cup and air supply means shown in Fig. 5, and with any of the forms it is possible to adjust the amount of air and oil and the proportions of air and oil and the outward velocities with which they are propelled, so that the homogenized fuel sheet or layer will be non-burning until it reaches the periphery of the hearth and will there burn in a wall of flame clinging to the walls of the furnace and extending into the flues. This

flame may be varied from a comparatively thin layer of dense yellow flame until the inner surface becomes more indefinite and more blue and the blue can be made to shade out towards the center until the entire furnace cavity is filled with a bluish almost invisible flame in lieu of the highly colored definite flame.

As will be understood from the foregoing, a very important feature of my invention is having the central centrifugal spray cup spraying the fuel oil in a narrow zone about the periphery of the hearth, at the base of the upright walls to be heated thereby, in such manner that the flame line is localized in said zone along said base and is prevented from creeping inward toward the central spray cup. The various contributing factors are in the aggregate so effective, that an ordinary commercial type motor turning 1700 to 1800 revolutions per minute can be directly coupled to the spray cup, although similar results may be achieved by the super-speed specially built motors now commonly used for such purposes.

An important factor tending to ensure this location of the flame line is the homogenizing and projecting with the spray of a relatively large volume of primary air propelled outward with and at approximately the same velocity as the spray, thus serving the double purpose of producing a better fuel draft while at the same time adding greatly to the volume, weight and carrying power that is practically effective in carrying the fuel. An important auxiliary factor is having this homogenized fuel draft projected along with an underlying draft layer of air traveling in the same direction and usually at the same or even greater speed than the highly carbureted part of the fuel draft.

Another important feature is locating the pilot light so that the first ignition of the spray, upon starting the apparatus, will be in said narrow zone about the periphery of the hearth, at the base of the upright walls, instead of near the spray cup. The initial combustion zone is thus remote from the intermediate surfaces of the hearth between the cup and the peripheral walls. Thus their initially cold surfaces remain cold until the entire combustion process above described is in full operation, and thereafter they are protected from being heated to combustion promoting temperature by the heat absorbing action of the unignited spray and air continuously projected from the center outward above said hearth surfaces.

I have found in certain cases, however, that if for any reason the flame line does break back to the homogenizer, it will continue there until the apparatus is stopped and restarted again. Hence in stopping and restarting, it is highly important to have the motor reach full speed before turning

on the oil and to turn off the oil before decreasing the speed of the motor.

While there are various ways of ensuring ignition at a point remote from the spray cup, I prefer the arrangement shown in Fig. 2, where the pilot light is shown as projecting its jet outward but at an angle inclined towards the observer, which, as will be noted, is substantially parallel with the direction of spray and draft tangentially projected from the spray cup and homogenizer. Preferably, this jet is directed against the surface of a cast iron member α' , which is kept hot by the continuously lighted pilot light impinging thereon at all times, regardless of whether the burner is or is not operating. Homogenized gases sweeping lengthwise along the flame of this pilot light may be ignited, particularly between it and the surfaces of α , thereby augmenting the effect of the pilot flame in igniting oil spray that may fall upon said surface and promoting circumferential progress of combustion around the periphery of the hearth.

The cast iron surface itself when hot tends to promote cracking of the heavy hydrocarbons to produce combustible methane and oxidation of carbon to produce carbon monoxide, but, if desired, the cast iron surface may be covered with refractory materials, including oxides or carbonates of well known catalytic metals. The lagging around the edge of the hearth where it curves into the upright surfaces of the furnace may be of similar refractory materials or may be of ordinary fire clay.

These refinements are not essential, however, because, when in full operation, mere impingement and deflection of my composite draft causes very high temperatures, say 1800° F. or more, in the annular zone of the corner between the periphery of the hearth and base of the furnace walls. Undoubtedly this intense heat evolution is largely the result of incomplete combustion or exothermic reaction yielding carbon monoxide and methane fuel gases along with some superheated steam and carbon dioxide products of some complete combustion that also occurs in this zone. Probably also the complete combustion is localized adjacent the hot furnace surfaces where the purer air naturally flows while the oil cracking and fuel gas reactions are mainly in the inwardly presented layers where there is only enough oxygen for the exothermic reactions and where diluent products of combustion entrained from within the furnace serve to slow down the oxidizing processes.

Whatever may be the precise details of working out of these reactions, the characteristic effect attained in full operation is sudden very high temperature in this narrow zone at the base of the walls resulting in the production of sufficient fuel gas to

complete the breaking down of all the fuel constituents of the draft and with decreasing temperatures as the slow bright flame flows up the walls of the furnace, until at the upper part and in the flues there is only the dark or blue flame characteristic of complete combustion of fuel gas. When the furnace has been brought to high temperature by this method, the air may be cut down until the combustion is nearly or entirely two-stage, i. e., exothermic reaction or partial oxidation producing fuel gases followed by slow complete combustion of said gases, evidenced by great decrease or even complete disappearance of the bright flame sheet and diffusing of dark or blue flame combustion from the walls toward the center of the furnace. Intermediate conditions are easily produced by simple changes of the proportions and quantities of oil and air.

The furnace, particularly the hearth, is an important factor, as will be evident from the fact that a burner cup provided with the homogenizer shown in Figs. 3 and 4, when operated in the open air without any hearth, will be found to deflect, and downwardly project the main body of the air draft at an angle of approximately 45°. Of course, no such thing happens in practice, because the hearth serves to support and guide the draft that sweeps its surface.

I claim:

1. Oil burning apparatus for use in a furnace having a combustion chamber with a stack gas outlet and a hearth with a central opening closing the lower end of said chamber, said apparatus including a mixing and projecting device in the opening in the hearth spaced therefrom to provide an annular inlet for a main draft of air entering the combustion chamber, and comprising rotary means having a rotor element to draw up oil and air therethrough, within the main draft annulus, and mix the same to produce a rich mixture and to project it laterally between the products of combustion in the combustion chamber and the main air draft, said rotor element including a deflector element above the path of said rich mixture adapted to force the main air draft outwardly above the hearth, said fuel draft entraining products of combustion at its upper surface and air at its lower surface.

2. Oil burning apparatus for use in a furnace having a combustion chamber with a stack gas outlet and a hearth with a central opening closing the lower end of said chamber, said apparatus including a mixing and projecting device arranged in the opening and spaced from the inner edge of said hearth to provide an annular inlet for a main draft of air entering the combustion chamber, and comprising means, including a

rotary element having outlet means at its periphery, to draw up oil and air and mix the same to produce a rich mixture and to project the mixture through said outlet means between the products of combustion in the combustion chamber and the main draft of air, annular deflecting means outside of said rotary element above the path of said fuel draft preventing direct upward movement of said main air draft through the combustion chamber and turning said main air draft outwardly above the hearth, whereby the fuel draft entrains products of combustion at its upper surface and air from said main air draft at its lower surface.

3. Oil burning apparatus for use in a furnace having a combustion chamber with a stack gas outlet and a hearth with a central opening closing the lower end of said chamber, said apparatus including a mixing and projecting device in the opening in the hearth spaced therefrom to provide an annular inlet for a main draft of air around the mixing and projecting device, and comprising a rotary element to draw up oil and air and mix the same to produce a rich mixture and to project said mixture laterally between the products of combustion in the combustion chamber and the main air draft, and to deflect the main air draft outwardly above the hearth so that the fuel draft strikes the upper portion of the main air draft, thus entraining products of combustion at its upper surface and air at its lower surface.

4. In an oil burning apparatus, means for projecting a fuel draft of oil and air in combustible relation to the air supply required for complete combustion, including a centrifugal carbureting cup, means for rotating said cup at high speed to atomize and project oil and primary air in an annularly spreading layer constituting the fuel draft, and means for directing the main air supply in an annulus surrounding said cup and in a direction for intersecting the path of the annular layer constituting the fuel draft, an annular deflector carried by the carbureting cup above the fuel draft, and inner and outer sets of propeller blades carried by said deflector and radially surrounding the annular outlet thereof to intercept, homogenize and propel the draft mixture impinging thereon.

5. In an oil burning apparatus, means for projecting a fuel draft of oil and air in combustible relation to the air supply required for complete combustion, including a centrifugal carbureting cup, means for rotating said cup at high speed to atomize and project oil and primary air in an annularly spreading layer constituting the fuel draft, means for directing the main air supply in an annulus surrounding said cup and in a direction for intersecting the path

of the annular fuel draft at an angle greater than forty-five degrees with an annular deflector carried by said cup arranged above the fuel draft or mixture of oil and primary air to deflect said main air supply whereby the inner portion of the main air supply tends to mingle with the annularly spreading fuel supply and all portions of the main air supply are deflected toward parallelism with said fuel draft.

6. In an oil burning apparatus, means for projecting a fuel draft of oil and air in combustible relation to the air draft required for complete combustion, including a centrifugal carbureting cup, means for rotating said cup at high speed to atomize and project oil and primary air in an annularly spreading layer constituting the fuel draft, means for directing the main air draft in an annulus surrounding said cup and in a direction for intersecting the path of the annular layer constituting the fuel draft at an angle greater than forty-five degrees, an annular deflector carried by said cup arranged above the fuel draft or mixture of oil and primary air to deflect said main air draft whereby the inner portion of the main air draft tends to mingle with the annularly spreading fuel draft and all portions of the main air draft are deflected toward parallelism with said fuel draft, said deflector being of much greater diameter than the fuel cup and having at its margin a downwardly directed flange member adapted to intercept the path of the centrifugally projected fuel draft from the carbureting cup and to baffle both the fuel draft and the portion of the main air draft impinging thereon.

7. In an oil burning apparatus, means for projecting a fuel draft of oil and air in combustible relation to the air draft required for complete combustion, including a centrifugal carbureting cup, means for rotating said cup at high speed to atomize and project oil and primary air in an annularly spreading layer constituting the fuel draft, means for directing the main air draft in an annulus surrounding said cup and in a direction for intersecting the path of the annular fuel draft at an angle greater than forty-five degrees, an annular deflector carried by said cup arranged above the fuel draft or mixture of oil and primary air to deflect said main air draft whereby the inner portion of the main air draft tends to mingle with the annularly spreading fuel draft and all portions of the main air draft are deflected toward parallelism with said fuel draft, said deflector being of much greater diameter than the fuel cup and having at its margin a downwardly directed flange member adapted to intercept the path of the centrifugally projected fuel draft from the carbureting cup and to baffle both

the fuel draft and the portion of the main air draft impinging thereon and having openings through which the deflected air and the baffled mixture may escape radially.

8. In an oil burning apparatus, means for projecting a fuel draft of oil and air in combustible relation to the air draft required for complete combustion, including a centrifugal carbureting cup, means for rotating said cup at high speed to atomize and project oil and primary air in an annularly spreading layer constituting the fuel draft, means for directing the main air draft in an annulus surrounding said cup and in a direction for intersecting the path of the annular fuel draft at an angle greater than forty-five degrees, an annular deflector carried by said cup arranged above the fuel draft or mixture of oil and primary air to deflect said main air draft whereby the inner portion of the main air draft tends to mingle with the annularly spreading fuel draft and all portions of the main air draft are deflected toward parallelism with said fuel draft, said deflector being of much greater diameter than the fuel cup and having at its margin a downwardly directed flange member adapted to intercept the path of the centrifugally projected fuel draft from the carbureting cup and to baffle both the fuel draft and the portion of the main air draft impinging thereon and having openings through which the deflected air and the baffled mixture may escape radially, said margin being formed with propeller blades radially intercepting, baffling and propelling outward the portion of the draft mixture impinging thereon.

9. In an oil burning apparatus, means for projecting oil and air in combustible relation, including a centrifugal spray means and means for rotating said first means at high speed to project the oil in an annular spreading layer of spray, in combination with a set of propeller blades and means for supporting the same in fixed relation with the centrifugal spray means but located radially outside of such spray means and extending across the plane of said annular layer of spray.

10. In an oil burning apparatus means for radially projecting oil and air in combustible relation, including a centrifugal spray cup having an annular outlet means for rotating said cup at high speed to project the oil in an annular spreading layer, an annular deflector carried by the spray cup above and extending radially beyond said outlet and inner and outer sets of propeller blades carried by said deflector and radially surrounding the annular outlet thereof to intercept, homogenize and propel the draft mixture impinging thereon.

11. In an oil burning apparatus, means for projecting oil and air in combustible re-

lation, including a centrifugal spray cup having an annular outlet, means for rotating said cup at high speed to project the oil in an annular spreading layer, an annular deflector carried by said spray cup in position to be struck by the oil projected from the cup and a fan carried by the spray cup and located radially beyond the annular outlet thereof to intercept, homogenize and propel the draft mixture impinging thereon.

12. A centrifugal spray cup having a peripheral edge or lip arranged to project atomized oil in a spreading sheet and carrying a set of impact members spaced apart from and encircling said lip, means for supplying air as a draft directed upon the atomized oil between the lip and said impact members, said impact members extending through the path of said atomized oil and into said air.

13. Apparatus of the class described, including means for forming an initial fuel draft consisting of an over-rich carbureted mixture of oil spray suspended in a relatively small percentage of primary air, means for supplying a main draft of air necessary for complete combustion, and rotary impact and propelling means for atomizing and initially mixing the spray in the initial fuel draft with said primary air and also with some additional primary air to form a homogenized fuel draft containing a relatively large percentage of air, and for projecting the same in close relation to the main draft of air necessary for complete combustion.

14. In an oil burning apparatus, means for projecting a fuel draft of oil and air including a centrifugal carbureting cup having oil and air inlets and an annular, upwardly and outwardly directed outlet passage and means for rotating said cup at high speed to atomize and project the oil and air mixture through said outlet in an upwardly and outwardly flaring fuel draft and to project atomized oil horizontally from the lower margin of said outlet, in combination with an annular deflector carried by said cup and formed with an annular, downwardly open baffle groove above the cup outlet and in the path of said fuel draft, the inner wall of said groove adjacent the cup outlet being more nearly parallel with the axis of the cup than is the outlet passage.

15. In an oil burning apparatus, means for projecting a fuel draft of oil and air including a centrifugal carbureting cup having oil and air inlets and an annular, upwardly and outwardly directed outlet passage and means for rotating said cup at high speed to atomize and project the oil and air mixture through said outlet in an upwardly and outwardly flaring fuel draft and to project atomized oil horizontally from the lower margin of said outlet, in

combination with an annular deflector carried by said cup and formed with an annular, downwardly open baffle groove above the cup outlet and in the path of said fuel draft, with dependent propeller blades supported outside of said groove and extending downward across the path of horizontal projection of drops of liquid from the lower margin of said outlet.

16. Oil burning apparatus, including a furnace, a refractory hearth at the bottom of the furnace, means for projecting an annularly spreading oil spray across said hearth, means for directing an upward draft of air across the path of the projected spray, a series of outwardly acting fan blades in an annulus spaced from and encircling said oil projecting means and extending across the path of the projected oil and into the air draft, a driving motor rotating said blades, and a refractory surrounding wall in position to intercept said spray, in combination with a gas flame nozzle directed toward said wall, laterally and obliquely, in the general direction of projection of the spray, and located near said wall, so that the heated jet from the flame impinges upon said wall.

17. Oil burning apparatus, including a furnace, a refractory hearth at the bottom of the furnace, means comprising a centrifugal spray head for projecting an annularly spreading oil spray across said hearth, means for directing an upward draft of air across the path of the projected spray, a series of outwardly acting fan blades in an annulus spaced from and encircling said oil projecting means and extending across the path of the projected oil and into the air draft, a driving motor rotating said blades, and a refractory wall around said hearth, in combination with a gas flame nozzle located near said wall and directed toward it laterally and obliquely, in the general direction of projection of the spray.

18. Oil burning apparatus, including a furnace, a refractory hearth having a draft opening therein at the bottom of the furnace, means comprising a centrifugal spray head positioned in said opening for projecting an annularly spreading oil spray across said hearth, means for directing an upward draft of air from said draft opening across the path of the projected spray, a series of outwardly acting fan blades in an annulus spaced from and encircling said oil projecting means and extending across the path of the projected oil and into the air draft, a driving motor rotating said blades, and a refractory wall around said hearth, in combination with a gas flame nozzle located near the periphery of the hearth and directed laterally and obliquely toward said periphery, in the general direction of projection of the spray.

19. In oil burning apparatus, means for

projecting an annularly spreading oil spray draft, and a driving motor rotating said
and means for directing an upward draft blades.
of air across the path of the projected spray, Signed at New York in the county of 10
a series of outwardly acting fan blades in an New York and State of New York this 31st
annulus spaced from and encircling said oil day of July, A. D. 1925.
5 projecting means and extending across the
path of the projected oil and into the air

FORREST A. HEATH.